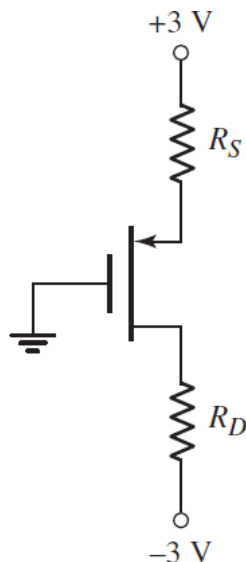


**ECE322L - Homework 1 (100 points)****Assigned on Thursday, 01/30/2020-11 am****Due on Thursday, 02/06/2020-11 am**

Consider the circuit below. The transistor parameters are  $V_{TP} = -0.40\text{ V}$  and  $K_p = 30\mu\text{A/V}^2$ . Design the circuit such that  $I_{DQ} = 60\mu\text{A}$  and  $V_{SDQ} = 2.5\text{ V}$ . (b) Determine the variation in Q-point values if  $V_{TP}$  increases by 5% and  $K_p$  decreases by 5% percent. Please, refer to the Neamen book for the transistor equations that you will need to solve this problem.



$$a) I_{DQ} = K_P (V_{SGQ} + V_{TP})^2 \quad \rightarrow \quad V_{SGQ} = \sqrt{\frac{I_{DQ}}{K_P}} - V_{TP} = \sqrt{\frac{60\mu\text{A}}{30\frac{\mu\text{A}}{\text{V}^2}}} + 0.4\text{V} = 1.8142\text{V}$$

$$V_{DD} = V_{SG} - I_D R_S \quad \rightarrow \quad R_S = \frac{V_{DD} - V_{SG}}{I_D} = \frac{3\text{V} - 1.8142\text{V}}{60\mu\text{A}} = 19.763\text{k}\Omega$$

$$V_{SD} = V_S - V_D \quad \rightarrow \quad V_D = V_S - V_{SD} = 1.8142\text{V} - 2.5\text{V} = -0.6858\text{V}$$

$$R_D = \frac{V_D - (-V_{SS})}{I_D} = \frac{-0.6858\text{V} - (-3\text{V})}{60\mu\text{A}} = 38.570\text{k}\Omega$$

$$Q - point = (V_{SGQ}, I_{DQ}) = (1.8142\text{V}, 60\mu\text{A})$$

$$b) K_{P_{new}} = K_P (1 - 0.05) = 30\frac{\mu\text{A}}{\text{V}^2} (1 - 0.05) = 28.5\frac{\mu\text{A}}{\text{V}^2}$$

$$V_{TP_{new}} = V_{TP} (1 + 0.05) = -0.4\text{V} (1 + 0.05) = -0.42\text{V}$$

$$I_{D_{new}} = K_{P_{new}} (V_{SGQ} + V_{TP_{new}})^2 = 28.5\frac{\mu\text{A}}{\text{V}^2} (1.8142\text{V} - 0.42\text{V})^2 = 55.398\mu\text{A}$$

$$Q - point_{new} = (V_{SGQ}, I_{DQ}) = (1.8142\text{V}, 55.398\mu\text{A})$$